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# Selection of Cow Dung for the Agnihotra Yajnya

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**ABSTRACT**

Agnihotra is a traditional domestic solemnity, performed to maintain harmony between living beings and nature, without harming and by giving respect. Agnihotra, the simplest forms of Yajnya performed at sunset/ sunrise in which cow dung is burned in the copper pot by using cow ghee and brown rice as oblations along with chanting of mantras of sun and fire. Dung of cow is a major component used in Agnihotra process. Composition of cow's dung varies according to the cow breed, cow metabolism, cow feed, etc. and hence selection of cow species for the dung is important. The sun dried dung of various 43 registered Indian cow (*Bos taurus indicus*) breeds were screened based on the extent of different products *viz.*, $O_2$, $CO_2$, CO, $H_2O$, $N_2$, SOx, NOx, PM, and ash produced after burning. The results showed that the dung of *Gir* cow's breed is most suitable for Agnihotra as compared to other Indian cow breeds.

***Key words****: Agnihotra, Indian Cow (Bos taurus indicus),* Gir *Cow, Cow Dung*

## Introduction

Agnihotra is a traditional homespun solemnity, performed to sustain amalgamation between nature and living beings, devoid of harming and by giving esteem. Agnihotra, the simplest types of 'Yagnya' performed at sunset or sunrise timing in which dried cow dung is burned in the copper pot with the specific dimensions by using brown rice mixed with cow ghee as oblations along with chanting of mantras of sun (at sunrise) and fire (at sunset). Agnihotra is mentioned and expounded by traditional Vedic literature, i.e., the Grihya-Sutra (Rules of Vedic household rituals) (Muller, 2004), as:

1.2, 1.9 and 1.10 of Asvalayana Grihya-Sutra,
1.1 and 1.3 of Gobhila Grihya-Sutra,
1.5 of Khadira Grihya-Sutra,
Some part of Sankhayana Grihya-Sutra.

Different forms of Agnihotra, in standpoint of components used, can be seen in the society. In several forms of Agnihotra about 26 dehydrated plants or its dried parts get used, which was mentioned by Kumar *et al.*, 2014, along with their elemental analysis. Around in the year of 1944, following the command of Lord Parshuram, Shree Gajanan Maharaj (1918 – 1987) from Akkalkot (India), standardized the methodology for Agnihotra and started propagating its use and benefits all over. Paranjpe, 1989; Potdar, 1993, etc. started escalating and disseminating the knowledge of this Agnihotra technology into many countries from 1970 onwards. At the concurrent moment, several scientists started enlightening the scientific basis for the advantageous effects of Agnihotra. Like Agnihotra yajnya, studies are going on other types of yajnya viz. Somyag yajnya (Abhang 2015 and Abhang *et al.*, 2016), Shrisukta yajnya (Abhang, 2015), with cow dung as major component of burning material. It has been reported by Pathade *et al*. (2014) and Abhang *et al*. (2015) Agnihotra yajnya have beneficial applications in the environment, agriculture and medicinal sectors. Although it's a mediaeval fire ritual, it is based on the

scientific facets, and various Colleges/ Institutions/ Universities, about more than fifty, are working on the Agnihotra technologies (Abhang *et al.* (2015 and 2017).

As the dung of cow is a major component used while performing Agnihotra and also composition of cow dung varies according to the cow breed, cow metabolism, cow feed, etc., it is important to select the breed of cow for dung. The cow dung after burning should produce more $O_2$, $CO_2$ and Ash; while that of less CO, $N_2$, $H_2O$, $SO_x$, $NO_x$, $PM_{2.5}$ and $PM_{10}$ to get rid of pollution due to dung along with complete combustion of dung.

## Materials and Methods

Dung of 43 registered cow (*Bos taurus indicus*) breeds (Table 1) all over India were collected by feeding them with same feed for a week. Collected dung was sun dried and then used for further experimentation.

One gram of sun-dried cow dung was placed in the Orsat Analyzer (Apex Instruments, VSC-33) and $O_2$, $CO_2$, CO, $H_2O$, $N_2$, Ash were estimated as described by Shaha, 1974.

For the analysis of SOx, NOx and PM about 100 g of sun dried dung of cow was burned in a closed room and the samples were collected with the help of Air Handy Sampler (Spectra Lab, HDS -8). The NOx analysis was done as described by Blacker *et al.*, 1972 and IS 5182 Part 6, 2006, the SOx analysis was done as described by West *et al*., 1956 and IS 5182 Part 2, 2006, while Particulate Matter ($PM_{2.5}$ and $PM_{10}$) was estimated as described by Srimuruganandam *et al.*, 2010.

### Score Calculation

With the help of concentrations of parameters viz., $O_2$, $CO_2$, Ash, CO, $N_2$, $H_2O$, $SO_x$, $NO_x$, $PM_{2.5}$ and $PM_{10}$, the score for all 43 dung of cow breeds was calculated by using following formula –

$$\text{Score} = \frac{\left(\frac{X_{iA}}{\bar{X}_A}\right)\left(\frac{X_{iB}}{\bar{X}_B}\right)\left(\frac{X_{iC}}{\bar{X}_C}\right)}{\left(\frac{X_{iD}}{\bar{X}_D}\right)\left(\frac{X_{iE}}{\bar{X}_E}\right)\left(\frac{X_{iF}}{\bar{X}_F}\right)\left(\frac{X_{iG}}{\bar{X}_G}\right)\left(\frac{X_{iH}}{\bar{X}_H}\right)\left(\frac{X_{iI}}{\bar{X}_I}\right)\left(\frac{X_{iJ}}{\bar{X}_J}\right)}$$

Where,

Xi = mean value of a parameter

X = average of all breeds of a parameter

A = $O_2$, B = $CO_2$, C = Ash, D= CO, E = $N_2$, F = $H_2O$, G = SOx, H = NOx, I = $PM_{2.5}$, J = $PM_{10}$

## Results and Discussion

It is evident from Table 2 that the maximum $O_2$ was evolved after burning the dung of *Gir* (12.31%) cow breed, followed by *Tharparkar* (11.98%), while that of minimum $O_2$ was evolved after burning the dung of *Mewati* (2.46%) cow breed. The maximum $CO_2$ was evolved after burning the dung of *Kosali* (21.89%) cow breed, followed by *Gaolao* (21.89%), while that of minimum $CO_2$ was evolved after burning the dung of *Kankrej* and *Sahiwal* (13.09%) cow breed, while burning of the dung of *Gir* cow breed evolved 21.78% of $CO_2$. The maximum CO was evolved after burning the dung of *Ladakhi* (3.77%) cow breed, followed by *Belahi* (3.67%), while that of minimum CO was evolved after burning the dung of *Amritmahal* and *Kangayam* (1.47%) cow breeds, while burning of the dung of *Gir* cow breed evolved 1.96% of CO. The maximum $N_2$ was evolved after burning the dung of *Amritmahal* (84.64%) cow breed, followed by *Sahiwal* (83.09%), while that of minimum $N_2$ was evolved after burning the dung of *Gir* (72.19%) cow breed. The maximum $H_2O$ was evolved after burning the dung of *Bachaur* (3.00%) cow breed, followed by *Deoni* (2.85%), while that of minimum $H_2O$ was evolved after burning the dung of *Kosali* (0.67%) cow breed, while burning of the dung of *Gir* cow breed evolved 1.8% of $H_2O$.

The maximum $SO_x$ was evolved after burning the dung of *Bargur* (11.27 µg/m$^3$) cow breed, followed by *Gaolao* and *Kherigarh* (7.51 µg/m$^3$), while that of minimum $SO_x$ was evolved after burning the dung of *Red Sindhi* (1.69 µg/m$^3$) cow breed, while burning of the dung of *Gir* cow breed evolved 2.33 µg/m$^3$of $SO_x$. The maximum $NO_x$ was evolved after burning the dung of *Amritmahal* (134.61µg/m$^3$) cow breed, followed by *Kherigarh* (131.5 µg/m$^3$), while that of minimum $NO_x$ was evolved after burning the dung of *Gir* (114.82 µg/m$^3$) cow breed. The maximum $PM_{2.5}$ and $PM_{10}$ are evolved after burning the dung of *Ladakhi* (39.02 µg/m$^3$ and 78.09 µg/m$^3$) cow breed, followed by *Belahi* (37.92 µg/m$^3$ and 75.89 µg/m$^3$), while that of minimum $PM_{2.5}$ and $PM_{10}$ are evolved after burning the dung of *Amritmahal* and *Kangayam* (15.16 µg/m$^3$ and 30.35 µg/m$^3$) cow breed, while burning of the dung of *Gir* cow breed evolved 19.62 µg/m$^3$and 40.43 µg/m$^3$ of $PM_{2.5}$ and $PM_{10}$, respectively. The maximum ash was produced after burning the dung of *Umblachery* (11.46%) cow breed, followed by *Binjharpuri, Motu, Red Sindhi, and Tharparkar* (10.42%), while that of minimum Ash

was produced after burning the dung of *Bargur* (2.08%) cow breed, while burning of the dung of *Gir* cow breed produced 9.38% of Ash. (Table 2)

According to the results ***Gir*** breed of cow showed highest score as compared to other cow breed (i.e. it evolved more $O_2$, $CO_2$ and Ash; and less CO, $N_2$, $H_2O$, $SO_x$, $NO_x$, $PM_{2.5}$ and $PM_{10}$ after burning) as 13.10, followed by *Khariar* cow breed as 11.13 and lowest by *Bargur* cow breed as 0.12 (Table 2 and Figure 1), hence dung of *Gir* cow breed was selected for further studies.

As the 100 g of cow dung burned within 1000 $m^3$

**Table 1.** List of Indian registered cow breeds

| Sr. No. | Breed | Distribution in India | Registration No. |
|---|---|---|---|
| 1 | *Amritmahal* | Karnataka | INDIA_CATTLE_0800_AMRITMAHAL_03001 |
| 2 | *Bachaur* | Bihar | INDIA_CATTLE_0300_BACHAUR_03002 |
| 3 | *Badri* | Uttarakhand | INDIA_CATTLE_2400_BADRI_03040 |
| 4 | *Bargur* | Tamilnadu | INDIA_CATTLE_1800_BARGUR_03003 |
| 5 | *Belahi* | Haryana and Chandigarh | INDIA_CATTLE_0532_BELAHI_03038 |
| 6 | *Binjharpuri* | Orissa | INDIA_CATTLE_1500_BINJHARPURI_03033 |
| 7 | *Dangi* | Maharashtra and Madhya Pradesh | INDIA_CATTLE_1104_DANGI_03004 |
| 8 | *Deoni* | Maharashtra and Karnataka | INDIA_CATTLE_1108_DEONI_03005 |
| 9 | *Gangatiri* | Uttar Pradesh and Bihar | INDIA_CATTLE_2003_GANGATIRI_03039 |
| 10 | *Gaolao* | Maharashtra and Madhya Pradesh | INDIA_CATTLE_1110_GAOLAO_03006 |
| 11 | *Ghumusari* | Orissa | INDIA_CATTLE_1500_GHUMUSARI_03032 |
| 12 | *Gir* | Gujarat | INDIA_CATTLE_0400_GIR_03007 |
| 13 | *Hallikar* | Karnataka | INDIA_CATTLE_0800_HALLIKAR_03008 |
| 14 | *Hariana* | Haryana, Uttar Pradesh and Rajasthan | INDIA_CATTLE_0520_HARIANA_03009 |
| 15 | *Kangayam* | Tamilnadu | INDIA_CATTLE_1800_KANGAYAM_03010 |
| 16 | *Kankrej* | Gujarat and Rajasthan | INDIA_CATTLE_0417_KANKREJ_03011 |
| 17 | *Kenkatha* | Uttar Pradesh and Madhya Pradesh | INDIA_CATTLE_2010_KENKATHA_03012 |
| 18 | *Khariar* | Orissa | INDIA_CATTLE_1500_KHARIAR_03034 |
| 19 | *Kherigarh* | Uttar Pradesh | INDIA_CATTLE_2000_KHERIGARH_03013 |
| 20 | *Khillar* | Maharashtra and Karnataka | INDIA_CATTLE_1108_KHILLAR_03014 |
| 21 | *Konkan Kapila* | Maharashtra and Goa | INDIA_CATTLE_1135_KONKANKAPILA_ 03043 |
| 22 | *Kosali* | Chhattisgarh | INDIA_CATTLE_2600_KOSALI_03036 |
| 23 | *Krishna Valley* | Karnataka | INDIA_CATTLE_0800_KRISHNAVALLEY_ 03015 |
| 24 | *Ladakhi* | Jammu and Kashmir | INDIA_CATTLE_0700_LADAKHI_03042 |
| 25 | *Lakhimi* | Assam | INDIA_CATTLE_0200_LAKHIMI_03041 |
| 26 | *MalnadGidda* | Karnataka | INDIA_CATTLE_0800_MALNADGIDDA_03037 |
| 27 | *Malvi* | Madhya Pradesh | INDIA_CATTLE_1000_MALVI_03016 |
| 28 | *Mewati* | Rajasthan, Haryana and Uttar Pradesh | INDIA_CATTLE_1705_MEWATI_03017 |
| 29 | *Motu* | Orissa, Chhattisgarh and Andhra Pradesh | INDIA_CATTLE_1526_MOTU_03031 |
| 30 | *Nagori* | Rajasthan | INDIA_CATTLE_1700_NAGORI_03018 |
| 31 | *Nimari* | Madhya Pradesh | INDIA_CATTLE_1000_NIMARI_03019 |
| 32 | *Ongole* | Andhra Pradesh | INDIA_CATTLE_0100_ONGOLE_03020 |
| 33 | *Ponwar* | Uttar Pradesh | INDIA_CATTLE_2000_PONWAR_03021 |
| 34 | *Pulikulam* | Tamilnadu | INDIA_CATTLE_1800_PULIKULAM_03035 |
| 35 | *Punganur* | Andhra Pradesh | INDIA_CATTLE_0100_PUNGANUR_03022 |
| 36 | *Rathi* | Rajasthan | INDIA_CATTLE_1700_RATHI_03023 |
| 37 | *Red Kandhari* | Maharashtra | INDIA_CATTLE_1100_REDKANDHARI_03024 |
| 38 | *Red Sindhi* | On organized farms only | INDIA_CATTLE_0000_REDSINDHI_03025 |
| 39 | *Sahiwal* | Punjab and Rajasthan | INDIA_CATTLE_1617_SAHIWAL_03026 |
| 40 | *Siri* | Sikkim and West Bengal | INDIA_CATTLE_2221_SIRI_03027 |
| 41 | *Tharparkar* | Rajasthan | INDIA_CATTLE_1700_THARPARKAR_03028 |
| 42 | *Umblachery* | Tamilnadu | INDIA_CATTLE_1800_UMBLACHERY_03029 |
| 43 | *Vechur* | Kerala | INDIA_CATTLE_0900_VECHUR_03030 |

(Source: ICAR-NBAGR - Indian Council of Agricultural Research - National Bureau of Animal Genetic Resources, 2012)

**Table 2**. Extent of $O_2$, $CO_2$, CO, $N_2$, $H_2O$, $SO_x$, $NO_x$, $PM_{2.5}$, $PM_{10}$ and Ash produced after burning of dungs of various registered Indian cow breeds.

| Sr No | Breed of Cow | Extent of different products produced upon burning of different cow dung samples | | | | | | | | | Ash (in%) | Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $O_2$ | $CO_2$ | CO (in %) | $N_2$ | $H_2O$ | $SO_x$ | $NO_x$ | $PM_{2.5}$ (in µg/m$^3$) | $PM_{10}$ | | |
| 1 | Amritmahal | 4.15 ± 0.64 | 13.61 ± 1.34 | 1.47 ± 0.14 | 84.64 ± 1.22 | 1.50 ± 0.30 | 2.82 ± 0.26 | 134.61 ± 1.88 | 15.16 ± 0.51 | 30.35 ± 0.77 | 5.21 ± 0.11 | **2.54** |
| 2 | Bachaur | 4.67 ± 0.72 | 15.19 ± 1.5 | 1.56 ± 0.15 | 82.58 ± 1.19 | 3.00 ± 0.60 | 3.76 ± 0.35 | 131.34 ± 1.83 | 16.17 ± 0.55 | 32.37 ± 0.82 | 4.17 ± 0.09 | **0.83** |
| 3 | Badri | 5.96 ± 0.92 | 15.84 ± 1.56 | 3.43 ± 0.32 | 78.95 ± 1.14 | 1.20 ± 0.24 | 3.66 ± 0.34 | 125.56 ± 1.75 | 35.47 ± 1.2 | 70.99 ± 1.79 | 9.38 ± 0.19 | **0.66** |
| 4 | Bargur | 5.44 ± 0.84 | 16.44 ± 1.62 | 2.35 ± 0.22 | 79.91 ± 1.15 | 1.35 ± 0.27 | 11.27 ± 1.05 | 127.09 ± 1.78 | 24.26 ± 0.82 | 48.55 ± 1.23 | 2.08 ± 0.04 | **0.12** |
| 5 | Belahi | 6.59 ± 1.02 | 20.91 ± 2.06 | 3.67 ± 0.34 | 73.22 ± 1.05 | 1.50 ± 0.30 | 5.87 ± 0.55 | 116.46 ± 1.63 | 37.92 ± 1.28 | 75.89 ± 1.91 | 6.25 ± 0.13 | **0.31** |
| 6 | Binjharpuri | 5.42 ± 0.84 | 14.4 ± 1.42 | 3.12 ± 0.29 | 81.12 ± 1.17 | 2.25 ± 0.45 | 3.00 ± 0.28 | 129.02 ± 1.8 | 32.24 ± 1.09 | 64.54 ± 1.63 | 10.42 ± 0.21 | **0.50** |
| 7 | Dangi | 11.79 ± 1.83 | 18.01 ± 1.78 | 2.54 ± 0.24 | 73.12 ± 1.05 | 2.1 ± 0.42 | 4.88 ± 0.46 | 116.29 ± 1.62 | 26.28 ± 0.89 | 52.6 ± 1.33 | 5.21 ± 0.11 | **1.01** |
| 8 | Deoni | 5.44 ± 0.84 | 19.69 ± 1.94 | 2.93 ± 0.27 | 76.1 ± 1.09 | 2.85 ± 0.57 | 7.04 ± 0.66 | 121.03 ± 1.69 | 30.32 ± 1.02 | 60.69 ± 1.53 | 4.17 ± 0.09 | **0.13** |
| 9 | Gangatiri | 6.43 ± 1.00 | 19.64 ± 1.94 | 2.13 ± 0.20 | 76.21 ± 1.10 | 1.2 ± 0.24 | 6.82 ± 0.64 | 121.21 ± 1.69 | 22.02 ± 0.74 | 44.06 ± 1.11 | 3.13 ± 0.06 | **0.71** |
| 10 | Gaolao | 5.96 ± 0.92 | 21.89 ± 2.16 | 3.13 ± 0.29 | 73.33 ± 1.05 | 0.75 ± 0.15 | 7.51 ± 0.70 | 116.62 ± 1.63 | 32.35 ± 1.09 | 64.74 ± 1.63 | 4.17 ± 0.09 | **0.48** |
| 11 | Ghumusari | 5.85 ± 0.91 | 17.86 ± 1.76 | 1.94 ± 0.18 | 78.63 ± 1.13 | 0.75 ± 0.15 | 6.2 ± 0.58 | 125.06 ± 1.75 | 20.01 ± 0.68 | 40.06 ± 1.01 | 3.13 ± 0.06 | **1.29** |
| *12* | *Gir* | 12.31 ± 1.91 | 21.78 ± 2.15 | 1.96 ± 0.18 | 72.19 ± 1.04 | 1.8 ± 0.36 | 2.33 ± 0.00 | 114.82 ± 1.60 | 19.62 ± 0.98 | 40.43 ± 1.02 | 9.38 ± 0.19 | *13.10* |
| 13 | Hallikar | 10.89 ± 1.69 | 13.72 ± 1.35 | 2.84 ± 0.27 | 77.75 ± 1.12 | 1.2 ± 0.24 | 5.45 ± 0.51 | 123.65 ± 1.73 | 29.31 ± 0.99 | 58.67 ± 1.48 | 5.21 ± 0.11 | **0.71** |
| 14 | Hariana | 3.76 ± 0.58 | 20.32 ± 2.01 | 1.86 ± 0.17 | 77.95 ± 1.12 | 1.05 ± 0.21 | 2.97 ± 0.28 | 123.98 ± 1.73 | 19.21 ± 0.65 | 38.44 ± 0.97 | 6.25 ± 0.13 | **3.24** |
| 15 | Kangayam | 2.98 ± 0.46 | 17.28 ± 1.71 | 1.47 ± 0.14 | 81.96 ± 1.18 | 1.12 ± 0.22 | 3.52 ± 0.33 | 130.36 ± 1.82 | 15.16 ± 0.51 | 30.35 ± 0.77 | 4.17 ± 0.09 | **2.12** |
| 16 | Kankrej | 8.16 ± 1.27 | 13.09 ± 1.29 | 2.54 ± 0.24 | 80.83 ± 1.16 | 1.05 ± 0.21 | 3.05 ± 0.29 | 128.56 ± 1.80 | 26.28 ± 0.89 | 52.6 ± 1.33 | 8.34 ± 0.17 | **2.14** |
| 17 | Kenkatha | 3.11 ± 0.48 | 16.44 ± 1.62 | 2.35 ± 0.22 | 81.76 ± 1.18 | 0.99 ± 0.2 | 3.76 ± 0.35 | 130.03 ± 1.82 | 24.26 ± 0.82 | 48.55 ± 1.23 | 6.25 ± 0.13 | **0.82** |
| 18 | Khariar | 5.42 ± 0.84 | 18.2 ± 1.80 | 1.83 ± 0.17 | 78.74 ± 1.13 | 0.93 ± 0.19 | 1.95 ± 0.18 | 125.24 ± 1.75 | 18.9 ± 0.64 | 37.83 ± 0.95 | 9.38 ± 0.19 | **11.13** |
| 19 | Kherigarh | 4.54 ± 0.7 | 13.51 ± 1.33 | 3.13 ± 0.29 | 82.68 ± 1.19 | 0.86 ± 0.17 | 7.51 ± 0.70 | 131.5 ± 1.84 | 32.35 ± 1.09 | 64.74 ± 1.63 | 4.17 ± 0.09 | **0.16** |
| 20 | Khillar | 5.44 ± 0.84 | 18.22 ± 1.8 | 2.05 ± 0.19 | 78.47 ± 1.13 | 0.8 ± 0.16 | 2.19 ± 0.21 | 124.8 ± 1.74 | 21.23 ± 0.72 | 42.49 ± 1.07 | 9.38 ± 0.19 | **8.25** |
| 21 | Konkan Kapila | 5.35 ± 0.83 | 19.06 ± 1.88 | 2.99 ± 0.28 | 76.73 ± 1.1 | 0.73 ± 0.15 | 3.59 ± 0.34 | 122.04 ± 1.7 | 30.94 ± 1.05 | 61.93 ± 1.56 | 8.34 ± 0.17 | **1.69** |
| 22 | Kosali | 4.86 ± 0.75 | 23.06 ± 2.28 | 2.72 ± 0.25 | 73.47 ± 1.06 | 0.67 ± 0.13 | 3.73 ± 0.35 | 116.85 ± 1.63 | 28.13 ± 0.95 | 56.3 ± 1.42 | 7.29 ± 0.15 | **2.49** |
| 23 | Krishna Valley | 3.37 ± 0.52 | 16.44 ± 1.62 | 2.44 ± 0.23 | 81.45 ± 1.17 | 1.2 ± 0.24 | 2.61 ± 0.24 | 129.54 ± 1.81 | 25.27 ± 0.85 | 50.58 ± 1.28 | 9.38 ± 0.19 | **1.41** |
| 24 | Ladakhi | 7.26 ± 1.12 | 18.26 ± 1.8 | 3.77 ± 0.35 | 75.18 ± 1.08 | 0.9 ± 0.18 | 7.25 ± 0.68 | 119.57 ± 1.67 | 39.02 ± 1.32 | 78.09 ± 1.97 | 5.21 ± 0.11 | **0.29** |
| 25 | Lakhimi | 5.96 ± 0.92 | 20.02 ± 1.98 | 2.01 ± 0.19 | 76.34 ± 1.1 | 0.75 ± 0.15 | 3.22 ± 0.30 | 121.41 ± 1.70 | 20.79 ± 0.70 | 41.62 ± 1.05 | 6.25 ± 0.13 | **5.38** |
| 26 | MalnadGidda | 6.12 ± 0.95 | 20.28 ± 2.00 | 3.19 ± 0.3 | 74.72 ± 1.07 | 1.95 ± 0.39 | 3.83 ± 0.36 | 118.83 ± 1.66 | 33.02 ± 1.12 | 66.09 ± 1.67 | 8.34 ± 0.17 | **0.63** |
| 27 | Malvi | 2.59 ± 0.40 | 18.85 ± 1.86 | 2.54 ± 0.24 | 79.6 ± 1.15 | 1.8 ± 0.36 | 6.10 ± 0.57 | 126.6 ± 1.77 | 26.28 ± 0.89 | 52.6 ± 1.33 | 4.17 ± 0.09 | **0.15** |
| 28 | Mewati | 2.46 ± 0.38 | 16.97 ± 1.68 | 2.93 ± 0.27 | 81.14 ± 1.17 | 1.65 ± 0.33 | 3.13 ± 0.29 | 129.05 ± 1.80 | 30.32 ± 1.02 | 60.69 ± 1.53 | 9.38 ± 0.19 | **0.38** |
| 29 | Motu | 5.99 ± 0.93 | 19.01 ± 1.88 | 3.33 ± 0.31 | 75.92 ± 1.09 | 1.65 ± 0.33 | 3.20 ± 0.30 | 120.74 ± 1.69 | 34.47 ± 1.16 | 68.99 ± 1.74 | 10.42 ± 0.21 | **0.87** |
| 30 | Nagori | 3.11 ± 0.48 | 18.85 ± 1.86 | 2.44 ± 0.23 | 79.29 ± 1.14 | 1.35 ± 0.27 | 2.61 ± 0.24 | 126.1 ± 1.76 | 25.27 ± 0.85 | 50.58 ± 1.28 | 9.38 ± 0.19 | **1.40** |
| 31 | Nimari | 3.89 ± 0.6 | 15.81 ± 1.56 | 3.32 ± 0.31 | 80.73 ± 1.16 | 0.75 ± 0.15 | 3.99 ± 0.37 | 128.39 ± 1.79 | 34.37 ± 1.16 | 68.79 ± 1.74 | 8.34 ± 0.17 | **0.59** |
| 32 | Ongole | 10.89 ± 1.69 | 19.06 ± 1.88 | 2.15 ± 0.20 | 73.22 ± 1.05 | 1.35 ± 0.27 | 2.3 ± 0.21 | 116.45 ± 1.63 | 22.24 ± 0.75 | 44.51 ± 1.12 | 9.38 ± 0.19 | **9.71** |
| 33 | Ponwar | 10.89 ± 1.69 | 13.72 ± 1.35 | 2.84 ± 0.27 | 77.75 ± 1.12 | 0.90 ± 0.18 | 5.45 ± 0.51 | 123.65 ± 1.73 | 29.31 ± 0.99 | 58.67 ± 1.48 | 5.21 ± 0.11 | **0.95** |
| 34 | Pulikulam | 9.72 ± 1.51 | 16.6 ± 1.64 | 3.43 ± 0.32 | 75.22 ± 1.08 | 2.25 ± 0.45 | 5.49 ± 0.51 | 119.63 ± 1.67 | 35.47 ± 1.2 | 70.99 ± 1.79 | 6.25 ± 0.13 | **0.29** |
| 35 | Punganur | 4.02 ± 0.62 | 19.06 ± 1.88 | 2.25 ± 0.21 | 78.57 ± 1.13 | 1.65 ± 0.33 | 2.4 ± 0.22 | 124.96 ± 1.75 | 23.25 ± 0.79 | 46.53 ± 1.17 | 9.38 ± 0.19 | **2.13** |
| 36 | Rathi | 5.05 ± 0.78 | 16.76 ± 1.65 | 2.64 ± 0.25 | 79.6 ± 1.15 | 1.80 ± 0.36 | 6.34 ± 0.59 | 126.6 ± 1.77 | 27.29 ± 0.92 | 54.62 ± 1.38 | 4.17 ± 0.09 | **0.22** |

**Table 2.** *Continued ...*

| Sr No | Breed of Cow | Extent of different products produced upon burning of different cow dung samples | | | | | | | Ash (in%) | Score |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $O_2$ | $CO_2$ | CO (in %) | $N_2$ | $H_2O$ | $SO_x$ | $NO_x$ | $PM_{2.5}$ (in µg/m$^3$) | $PM_{10}$ | | |
| 37 | Red Kandhari | 5.44 ± 0.84 | 17.28 ± 1.71 | 3.03 ± 0.28 | 78.36 ± 1.13 | 1.80 ± 0.36 | 3.64 ± 0.34 | 124.63 ± 1.74 | 31.34 ± 1.06 | 62.72 ± 1.58 | 8.34 ± 0.17 | **0.58** |
| 38 | Red Sindhi | 5.31 ± 0.82 | 16.23 ± 1.6 | 1.76 ± 0.16 | 80.83 ± 1.16 | 1.80 ± 0.36 | 1.69 ± 0.16 | 128.56 ± 1.8 | 18.19 ± 0.61 | 36.42 ± 0.92 | 10.42 ± 0.21 | **6.85** |
| 39 | Sahiwal | 4.92 ± 0.76 | 13.09 ± 1.29 | 2.84 ± 0.27 | 83.09 ± 1.2 | 1.95 ± 0.39 | 3.03 ± 0.28 | 132.16 ± 1.85 | 29.31 ± 0.99 | 58.67 ± 1.48 | 9.38 ± 0.19 | **0.54** |
| 40 | Siri | 4.92 ± 0.76 | 16.55 ± 1.63 | 1.66 ± 0.16 | 80.94 ± 1.16 | 1.95 ± 0.39 | 2.00 ± 0.19 | 128.72 ± 1.8 | 17.18 ± 0.58 | 34.39 ± 0.87 | 8.34 ± 0.17 | **4.79** |
| 41 | Tharparkar | 11.98 ± 1.86 | 15.09 ± 1.49 | 3.12 ± 0.29 | 75.24 ± 1.08 | 1.35 ± 0.27 | 3.00 ± 0.28 | 119.66 ± 1.67 | 32.24 ± 1.09 | 64.54 ± 1.63 | 10.42 ± 0.21 | **2.24** |
| 42 | Umbla-chery | 4.42 ± 0.68 | 20.97 ± 2.07 | 2.47 ± 0.23 | 76.14 ± 1.1 | 1.65 ± 0.33 | 2.16 ± 0.20 | 121.1 ± 1.69 | 25.57 ± 0.86 | 51.18 ± 1.29 | 11.46 ± 0.23 | **2.80** |
| 43 | Vechur | 5.56 ± 0.86 | 18.43 ± 1.82 | 2.90 ± 0.27 | 77.27 ± 1.11 | 0.75 ± 0.15 | 3.49 ± 0.33 | 122.9 ± 1.72 | 30.02 ± 1.01 | 60.09 ± 1.52 | 8.34 ± 0.17 | **1.84** |

(Results expressed as Mean ± SE, where n = 3)

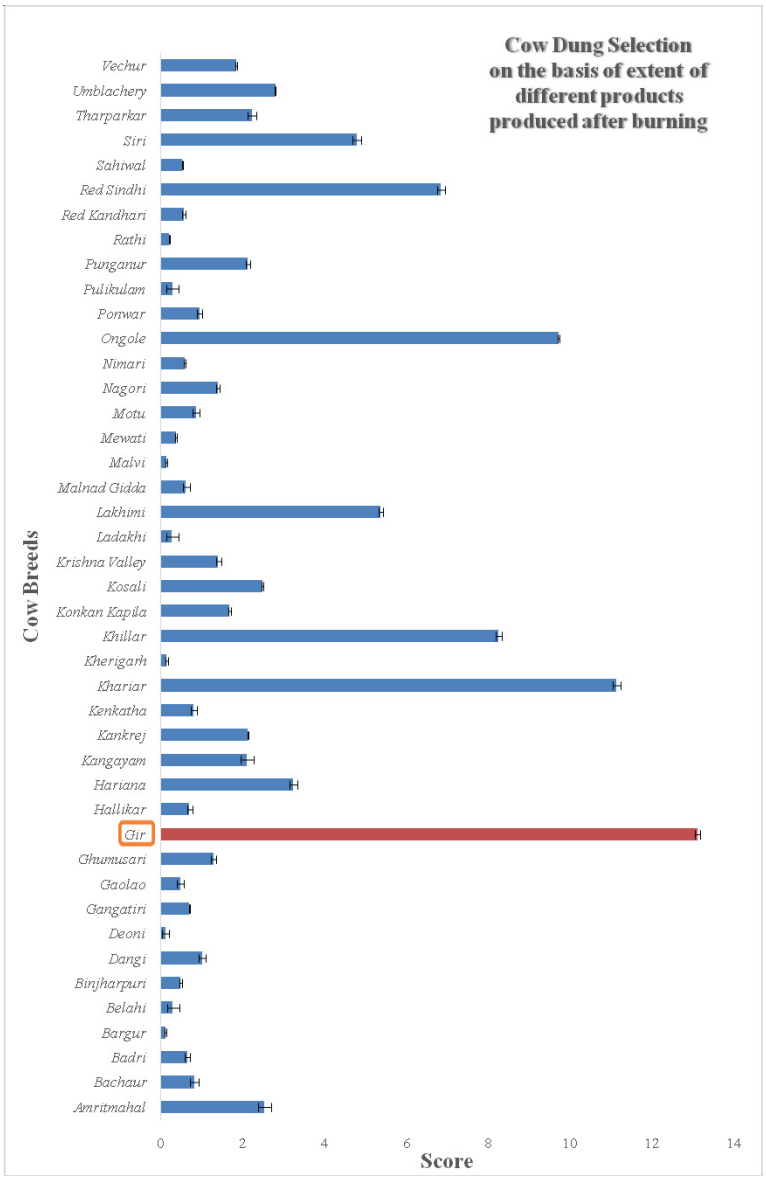


**Fig. 1.** Comparison of scores for cow breeds

area, the concentrations of SOx were ranged from 0.02 g to 0.12 g per Kg of cow dung while that of the concentrations of NOx were ranged from 1.1 g to 1.3 g per Kg of cow dung. Our results were found to be analogous with the results of Garg *et al.*, 2001 (where SOx and NOx concentrations was 0.06 g/Kg of and 0.86 g/Kg of burned cow dung, respectively), and Brocard *et al.*, 1996 (where SOx and NOx concentrations was 0.12 g/Kg of and 0.8 g/Kg of burned cow dung, respectively). But our results showed lesser SOx and NOx generation after burning of cow dung when compared with the results of Venkataraman *et al.*, 1999 (1.55 g of SOx got emitted per Kg of cow dung), Van Andreae *et al.*, 1988 (SOx and NOx in the range of 2 to 2.4 g/Kg of cow dung), Smith, 1988 and Arndt *et al.*, 1997 (6 g of SOx got emitted per Kg of cattle dung).

As the 100 g of cow dung burned within 1000 cubic meter area, the concentrations of PM were ranged from 0.15 g to 0.78 g per Kg of cow dung. Our results were found to be analogous with the results of Park *et al.*, 2013, where PM concentrations ranged from 0.4 g/Kg to 0.6 g/Kg with variation in $CO_2$ factor. But our results showed lesser PM generation after burning of cow dung when compared with the results of Saud *et al.*, 2011 (15.68 g PM per Kg of cow dung), Saud *et al.*, 2013 (16.26 g PM per Kg of cow dung) and Sen *et al.*, 2014 (5.37 g PM per Kg of cow dung).

## Conclusion

Dung of cow is a major component used in Agnihotra process. Composition of cow's dung varies according to the cow breed, cow metabolism, cow feed, etc. and hence selection of cow species for the dung is important. According to the results *Gir* breed of cow showed highest score as compared to other cow breed i.e. it evolved more $O_2$, $CO_2$ and Ash; and less CO, $N_2$, $H_2O$, $SO_x$, $NO_x$, $PM_{2.5}$ and $PM_{10}$ after burning of dung. Hence the dung of *Gir* cow's breed is most suitable for Agnihotra as compared to other Indian cow breeds.

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### Conflict of Interest

Authors do not have any conflict of interest to declare.

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